Population Dynamics of *Acyrthosiphon pisum* (Homoptera: Aphididae) and Its Natural Enemies on *Pisum sativum* (L.)

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Abstract

The seasonal abundance of pea aphid, *Acyrthosiphon pisum* (Harris) was studied in field peas at Denbi and Kulumsa, Ethiopia from 1995 to 1997. Foliage samples form 50 randomly selected plants were taken in plots and farmers fields to estimate the aphid populations. Aphids first appeared in late July or early August, 40-60 days after crop emergence, but populations remained low throughout July. Populations increased in September in all years coinciding with flowering and podding growth phases, the period most sensitive to aphid damage. In general, aphid populations reached a peak in the latter half of September and showed a sharp decline in October as plants senesced.

The natural enemies of aphids recorded were coccinellids (*Cheilomenes lunata* and *C. sulphurea),* syrphids and braconid wasps (*Aphidius* spp.) natural enemy populations followed trend similar to that of aphids, and the highest density was recorded in early September. The population of predators was low at all locations with the highest record of 9 per 50 sampled plants. The parasitiods caused up to 42% mortality of aphids at Kulumsa in 1995 indicating their importance as biological control agents. The appearance of natural enemies was late and lagged behind the pest population which reached economic injury level.

Introduction

The bulk of Ethiopia grain legumes are produced by subsistence farmers whose yields average among the lowest in the world (300-500 kg/ha). Constraints to production are many, but the pea aphid is a major concern to pea productivity.

The pea aphid, *Acyrthosiphon pisum* (Harris)is an economic pest of pea (*Pisum sativum*), lentil (*Lens culinaris)* and grasspea *(Lathyrus sativus)* in Ethiopia. Avoidable yield losses in pea reach up to 78% with an average of 36.8% in different regions and under different farming systems (IAR, 1987; Hailu & Tadesse, 1989; Kemal, 1995; Lemma et al, 1996 and Kemal, 1997). The pest may cause complete crop failure in bad years, however, where the amount and distribution of rainfall is good, there may be little or no damage by aphids. This is specially marked in regions with low rainfall or during seasons in which the rainfall is inadequate. In places of high rainfall, like Bekoji (2700m) this aphid does not reach to a pest level. Pea aphid damage is more serious in mid-altitude (1800-2200m) areas of the country.

Although pea aphid in general was regarded as important pest, its seasonal fluctuations together with its natural enemies were not known in Ethiopia. In Canada and USA the abundance of pea aphid has been studied in peas (Dunn & Wright, 1955; Cooke 1963; and Maiteki 1986). Two peaks in population are reported, one in late spring or early summer and the other in late summer or early fall. The possibility of timing and level of infestation of pea aphid, a pest of economic importance, was also investigated in Sweden (Bommarco & Ekbom, 1995).

Basic knowledge of the potential population growth rate of the key pest species in relation to potential biological control agents and weather conditions are essential for designing an effective pest management program. Therefore, the present study describes the seasonal changes of pea aphid and its natural enemies in field pea in Ethiopia.

Materials and Methods

The experiment was conducted at Denbi (1995 to 1997) and Kulumsa (1995 to 1996); both sites are
located in the southeastern part of Ethiopia. These sites are the two hot spot areas for pea aphid.

Kulumsa is situated at 39^0 11'E 80 03'N at an altitude of 2130 m. The mean annual temperature is 23^0C, mean minimum temperature $10^0$2 C, mean maximum 23.^{0}C and annual rainfall is 840 mm. Denbi is located on 38^0 59'E 8^0 46'N at an altitude of 1930 m. Mean annual temperature is 24^0C with mean maximum and mean minimum temperatures of 25^0C and ^{0}9 C respectively. Annual rainfall is reported as 847 mm.

Field pea variety, Mohanderfer, was seeded in 78 x 25m plots with row spacing of 20 cm. All common practices of the crop were followed and no fertilizer was applied. Aphid sampling was initiated two weeks after plant emergence and continued at weekly intervals throughout the season. Whole plants were examined during the first few weeks of the season, but as the plants grew larger only terminal 20-30 cm of a stem tips were taken. On each sampling occasion, fifty randomly selected plants were sampled. The aphid of all ages were carefully searched and counted. Different species of predators were estimated by counting adults and larvae on the 50 sampled plants. Percent parasitism was also computed by counting mummified aphids on each plant every sampling date. Available metreological data of the specific locations were recorded.

Pea aphid was also sampled in 14 farmers' fields around Debre Zeit (mid-altitude) in 1997 where most of field peas are produced. The procedures followed for sampling was as described in plots except sampling was on fortnightly basis. After aphids are sampled, note was made on the stage of plant development at each site.

Results and Discussion

As shown in Figure 1 and 2 the pea aphid had two main peak populations in 1995/96 season at Denbi, the first peak was at the initiation of flowering of the crop at the end of August (47 aphids/plant). The second period of pea aphid activity occurred at the end of September (58 aphid/plant) when the amount of rainfall decreased. The aphid population steadily declined in October when the crop started maturing and night temperature falling down (7.9^0C). Likewise, the peak of aphid population at Kulumsa in the same season was recorded in mid-August (39 aphid/plant) and the population remained high up to the end of the month. The density of aphid showed a sharp decline in late August and only few aphids observed up to mid-September. The pest infestation appeared two weeks early at Kulumsa compared with that of Denbi. The early appearance of pea aphid at Kulumsa in this particular season was associated with the delay of rainfall in the first part of the season (August).

The natural enemies recorded in these two locations were Coccinellids (*Cheilomenes lunata* and *C. sulphurea*), Syrphids and Braconids (*Aphidius* Spp.). The third was dominant at Kulumsa. The population of the natural enemies followed more or less the same trend to that of their prey and the highest population density was recorded around late August and early September (Figure 1 & 2). The parasitiods have resulted up to 42% mortality of aphids at Kulumsa indicating the highest potential as bio-control agents of the pest while it was only 1.2 % mortality at Denbi the same year.

The statistical analysis revealed that the aphid population was negatively correlated but not significant with the rainfall (r=-0.0254). In general, the period of peak activities of the aphids coincided with full flowering and early pod setting stage of the crop. A rapid increase in number in response of stoppage of rains is

typical of pea aphid survival and reproductive period. As a result, large populations, consisting nymphs and adults invade the crop at flowering.

The results of the two locations in 1996 crop season are presented in Figure 3 and 4. At Denbi, The aphid populations showed steady progress from mid-August (6 weeks after crop emergence) and peaked in the first week of September (41 aphids/plant) and declined sharply thereafter. There were no two clear peak populations in the season. This might have been attributed because of exceptionally high rainfall received during 1996/97.

The overall impact of the natural enemies on aphid population at Denbi was very low. Coccinellids, in particular occurred in negligible proportions (4 in the season), however; parasitiods have contributed up to 7.6 % mortality, which was also low.

At Kulumsa, the pea aphid population was very high in this season compared to the previous year. The aphids had two peaks, the first small peak (93 aphid/plant) was recorded in mid-August and the second was in late September (206 aphid/plant). The natural enemies appeared early in the season as the aphid populations started increasing at Kulumsa. The activities of predators mainly Coccinellids followed similar trend to that of aphids and reached a peak of 7 and 9 in July and September respectively (Figure 4). Percent parasitism was very low with the highest record of 3.1.

In each year, aphids first appeared in late July or early August and densities remained low through July and then increased to a peak in the latter half of August. After reaching a peak, the densities dropped sharply in late September and did not recover prior to harvest. This pattern was observed at both locations in all years. The pea aphid numbers begun to increase rapidly just before flowering and peak numbers were attained at flowering. During flowering stage, most of the products of photosynthesis move upward to developing pods. During this period the aphids were concentrated on the upper young leaves and developing pods as it was observed in all occasions. In 1996, patterns of abundance were similar to those of 1995, except the peak occurred about the third weeks of August at full flowering. The population decline coincided with the period when leaves on the last 25% of the nodes were scenescing and pods were beginning to dry. In 1997 at Denbi, the pea aphid population was low compared with the previous two years and the peak was observed in September with the highest count of 12 per plant. Likewise, the natural enemies remained low with maximum count of 3 Coccinellids in late September. Similar trend was noted in farmers' field samples around Debre Zeit. The aphid appeared in the first week of August and showed steady increase with the highest mean count of 14 aphid/plant in mid-September in 1997. It was good harvest of peas for these farmers. In general, the seasonal abundance of pea aphid consistently coincided with flowering period of the host crop. Infested plants during this period and early pod stages was reported to lead to plant deformation and high yield-losses which resulted primarily from aphid feeding damage to the flowers and filling pods (Barlow et al. 1977, Maiteki & Lamb, 1985). It was also evident that aphid population fluctuated considerably from one season to another with initial infestations starting around first week of August. This population fluctuation of the pea aphid was mainly due to rainfall because the pest is very sensitive to rain and can be washed off from the plant. Finally to manage pea aphid, this information can be utilized to know when to begin field surveys and control measures to be used.

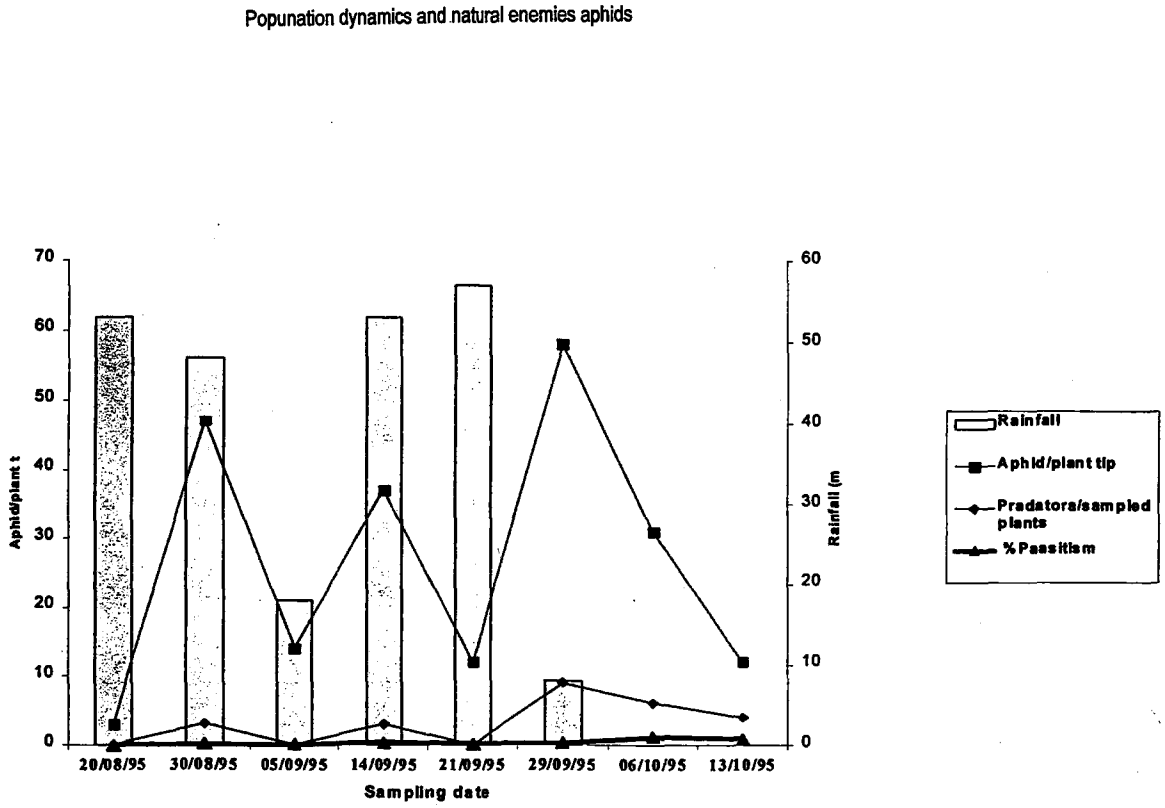

Fig.1. Average number of pea aphid, natural enemies per plant or stem tip in plots of field peas and rainfall at Deabi in 1995.

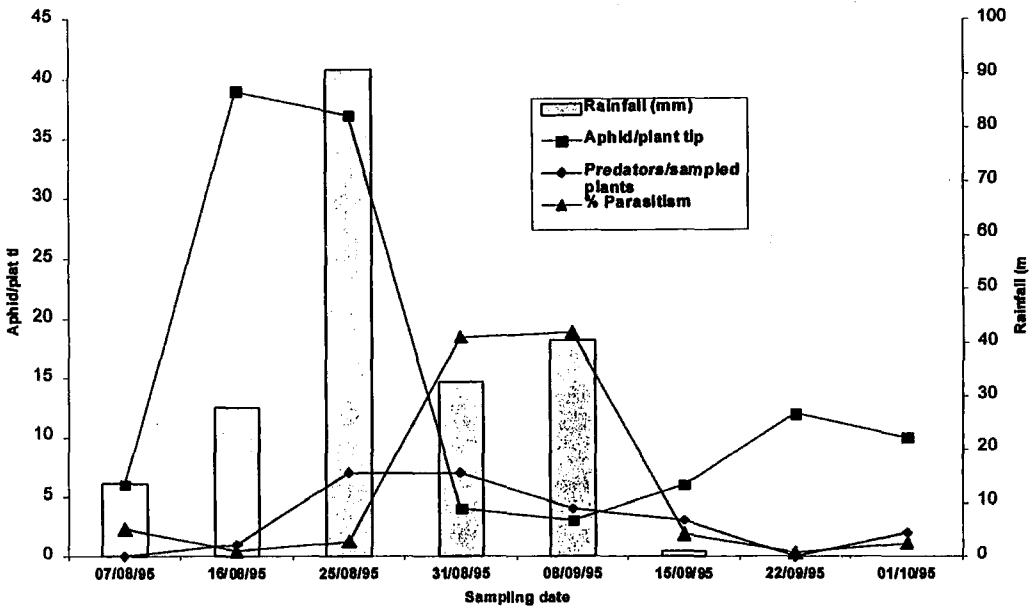

Fig. 2. Average number of pea aphid and natural enemies plant or stem tip of field peas and rainfall at Kulumsa in 1996.

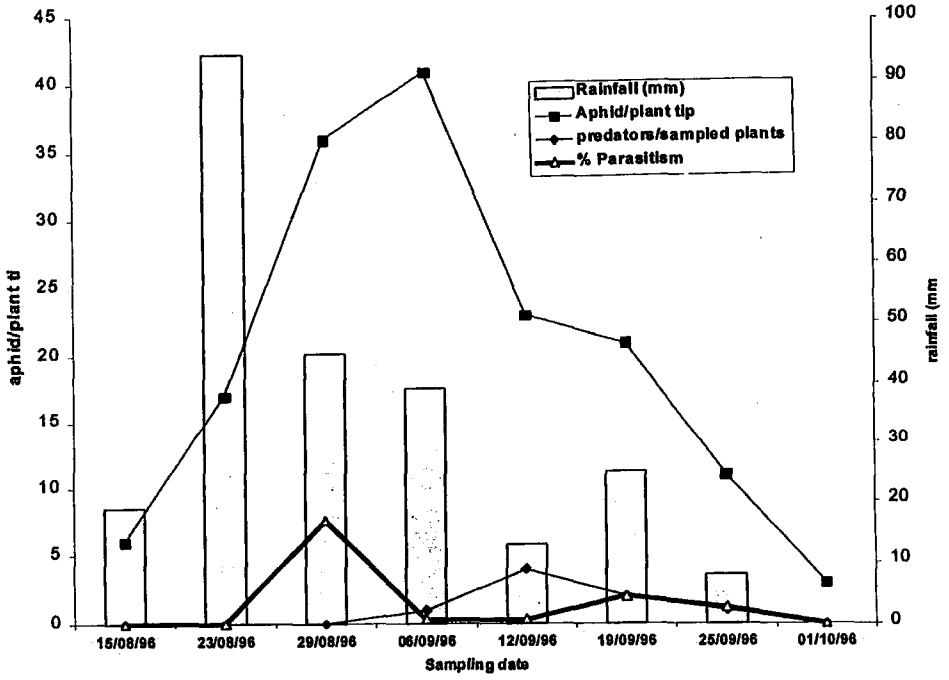

Fig.3. Average number of pea aphid and natural enmies per plant or stem tip in plots of field peas and rainfall at Denbi in 1996.

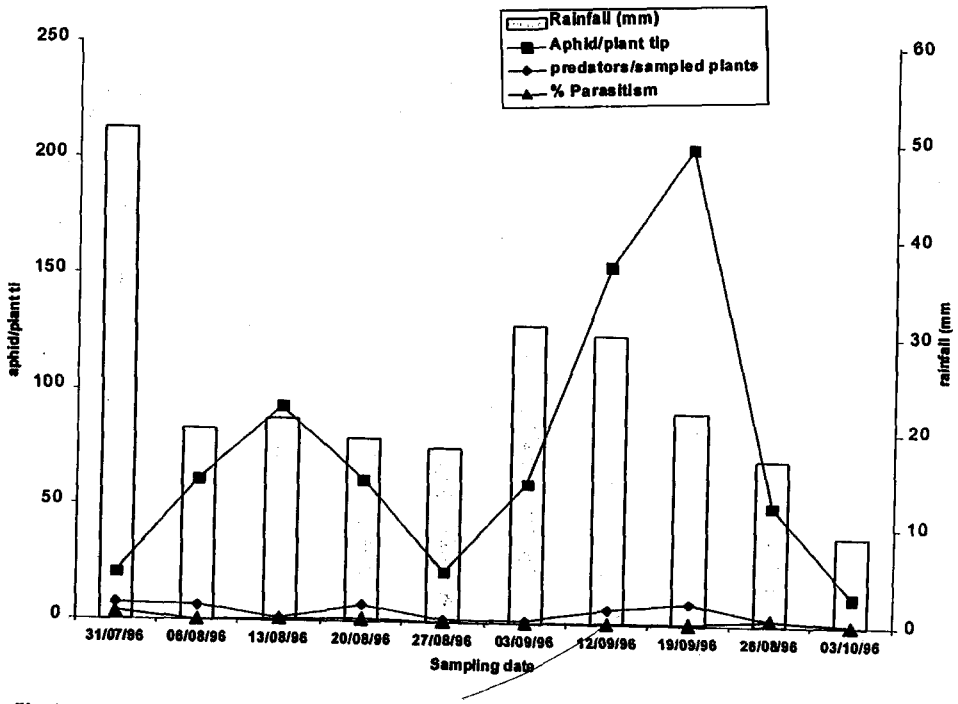

Fig. 4. Average number of pea aphid and natural enemies per plant or stem tip in plots of field peas and rainfall at Kulumsa in 1996.

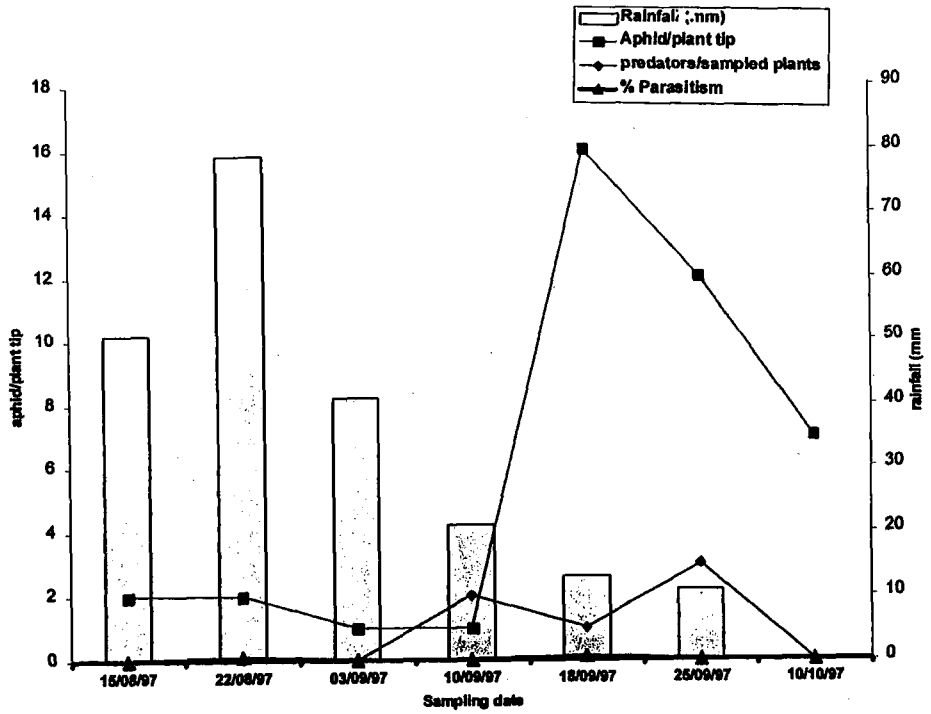

Fig. 5. Average number of pea aphid and naturla enemies per plant or stem tip in plots of field peas and rainfall at Denbi in 1997.

Acknowledgements

I thank Ato Tezera Wolabu for technical assistance, Ato Melaku Tesfaye and Terefe Tariku for their help in data collection at Kulumsa Resaerch Center. I am also grateful to entomology staffs of Holetta Research Center, Ato Belay Eshetu and Ato Alemu Kebede for technical support and data collection and farmers who allowed us to sample their fields.

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